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Davis

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(54) **APPARATUS AND METHOD OF WASTE ENERGY RECOVERY FROM A SOURCE OF HEATED FLUID**

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F01P 3/20 (2006.01)
F24D 15/00 (2006.01)

(52) **U.S. Cl.**
CPC ***F02G 5/00*** (2013.01); ***F01P 3/20*** (2013.01); ***F24D 15/00*** (2013.01); *F01P 2025/04* (2013.01); *F01P 2025/08* (2013.01); *F01P 2060/08* (2013.01); *F01P 2060/18* (2013.01); *F24D 2200/26* (2013.01)

(58) **Field of Classification Search**
USPC 237/12, 12.1
See application file for complete search history.

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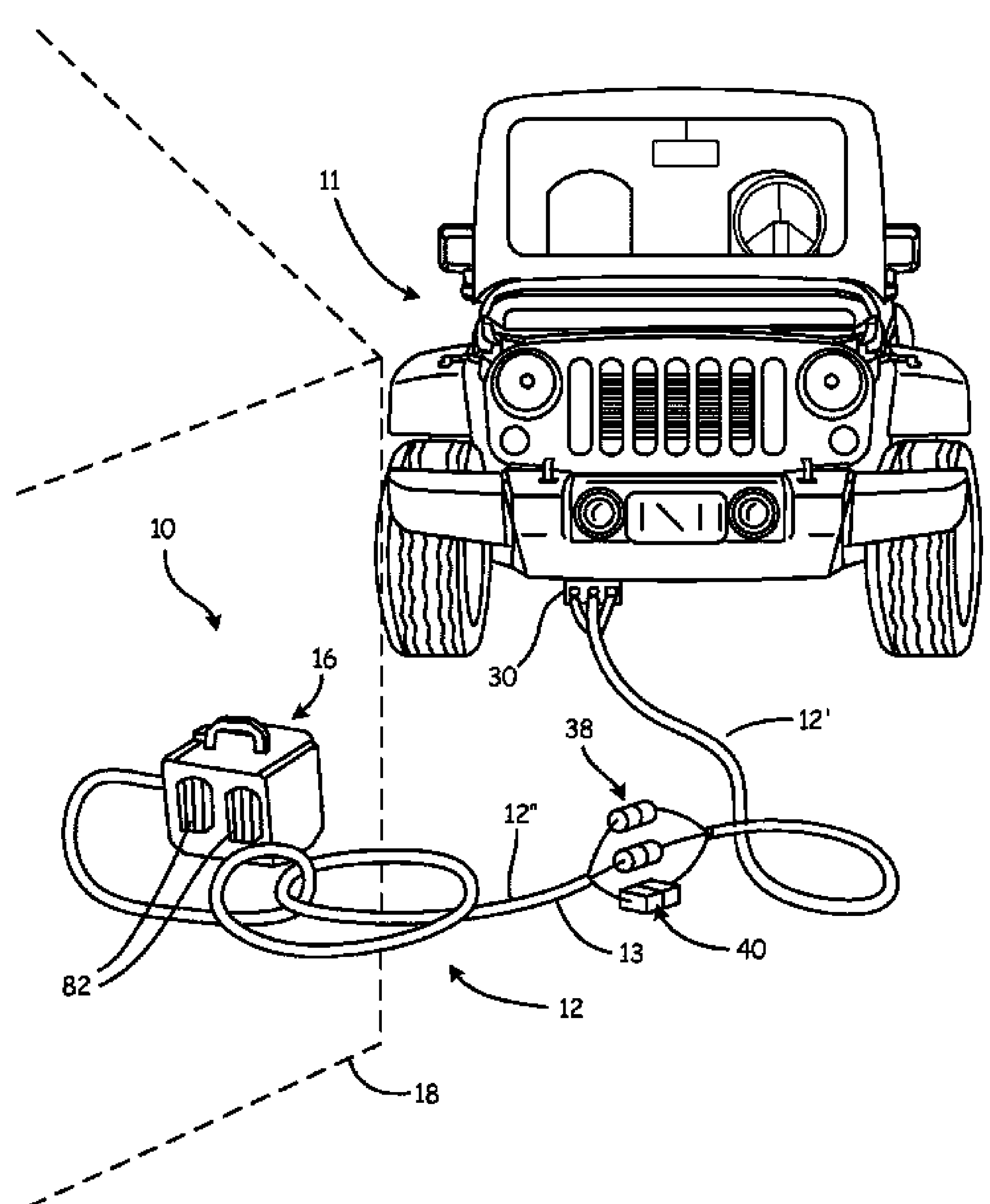
(57) **ABSTRACT**

A system and method of recovering waste heat from an engine when the engine is not operating, which includes connecting a heater core to source of fluid heated due to operation of the engine with fluid lines, the flow of fluid from the source of heated fluid controlled by one or more pump, and operating the pumps when the engine is not operating to circulate the fluid from the source of heated fluid through the heater core. A second aspect includes a portable heat recovery system.

33 Claims, 7 Drawing Sheets



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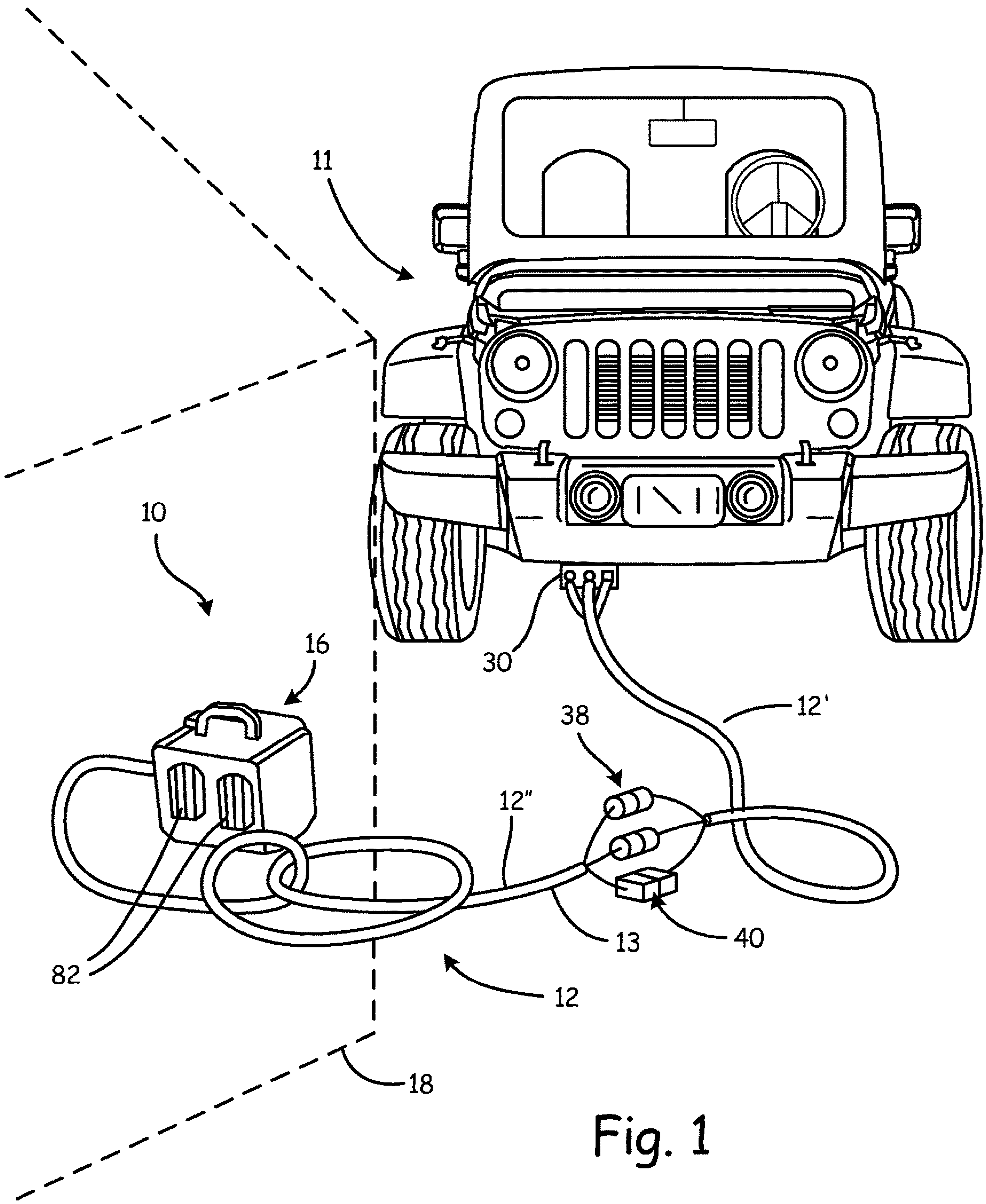

Fig. 1

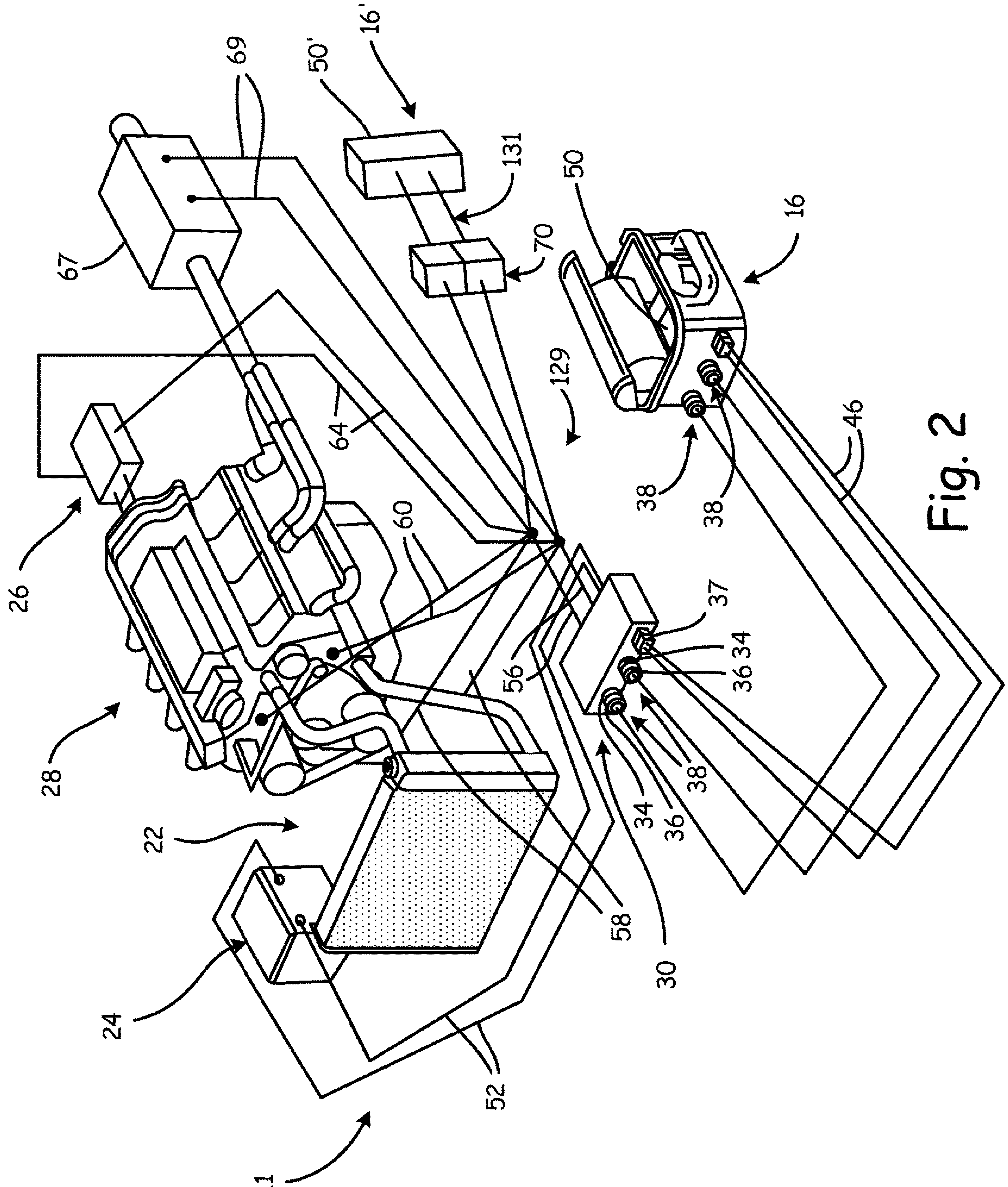
67
69
50'
16'
131
70
50
16
129
64
26
60
28
22
24
52
11
58
56
30
34
36
38
37
34
36
38
38
46

Fig. 2

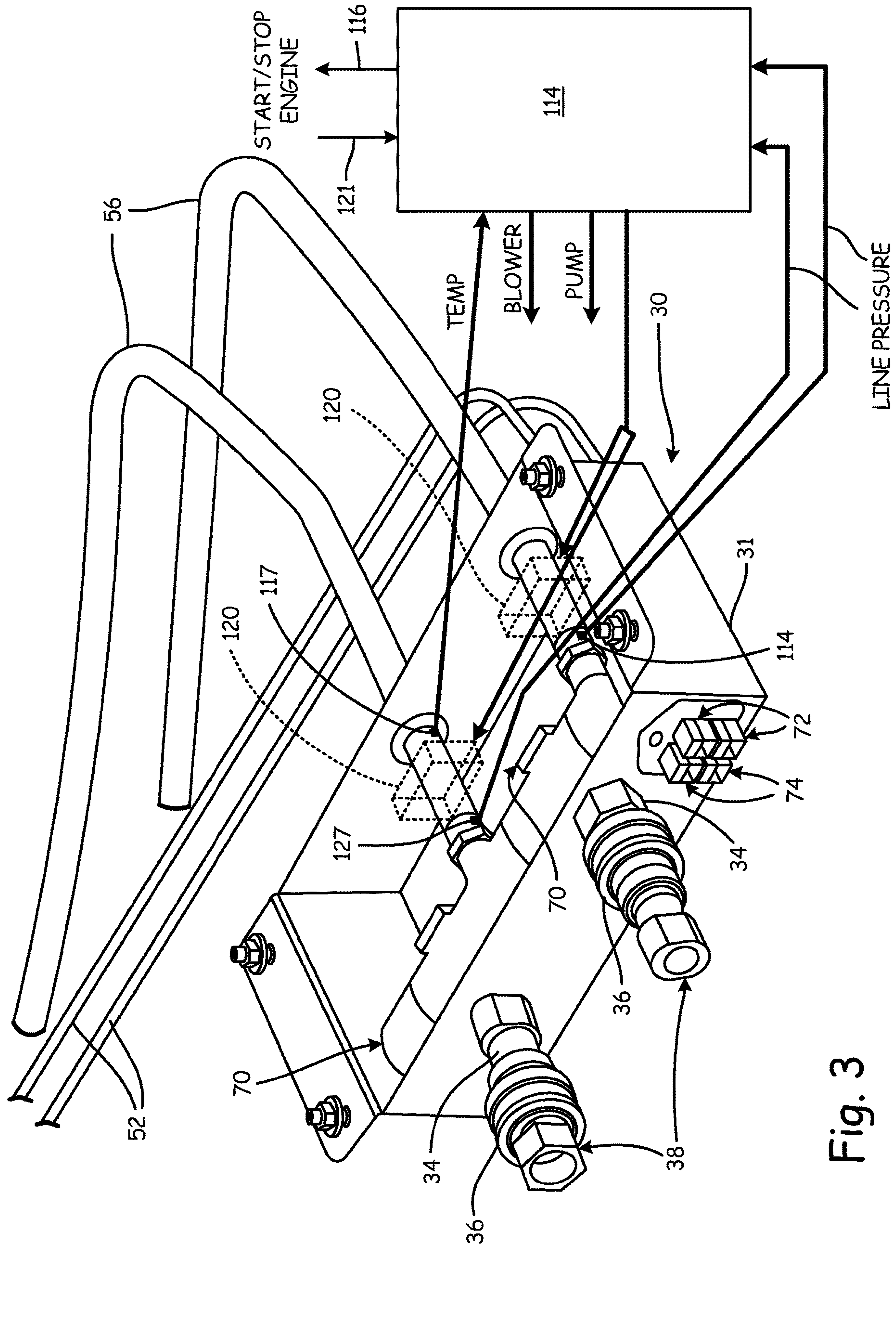
START/STOP
ENGINE
116
121
114
TEMP
BLOWER
PUMP
LINE PRESSURE
30
56
120
117
31
114
72
74
34
127
70
36
38
52

Fig. 3

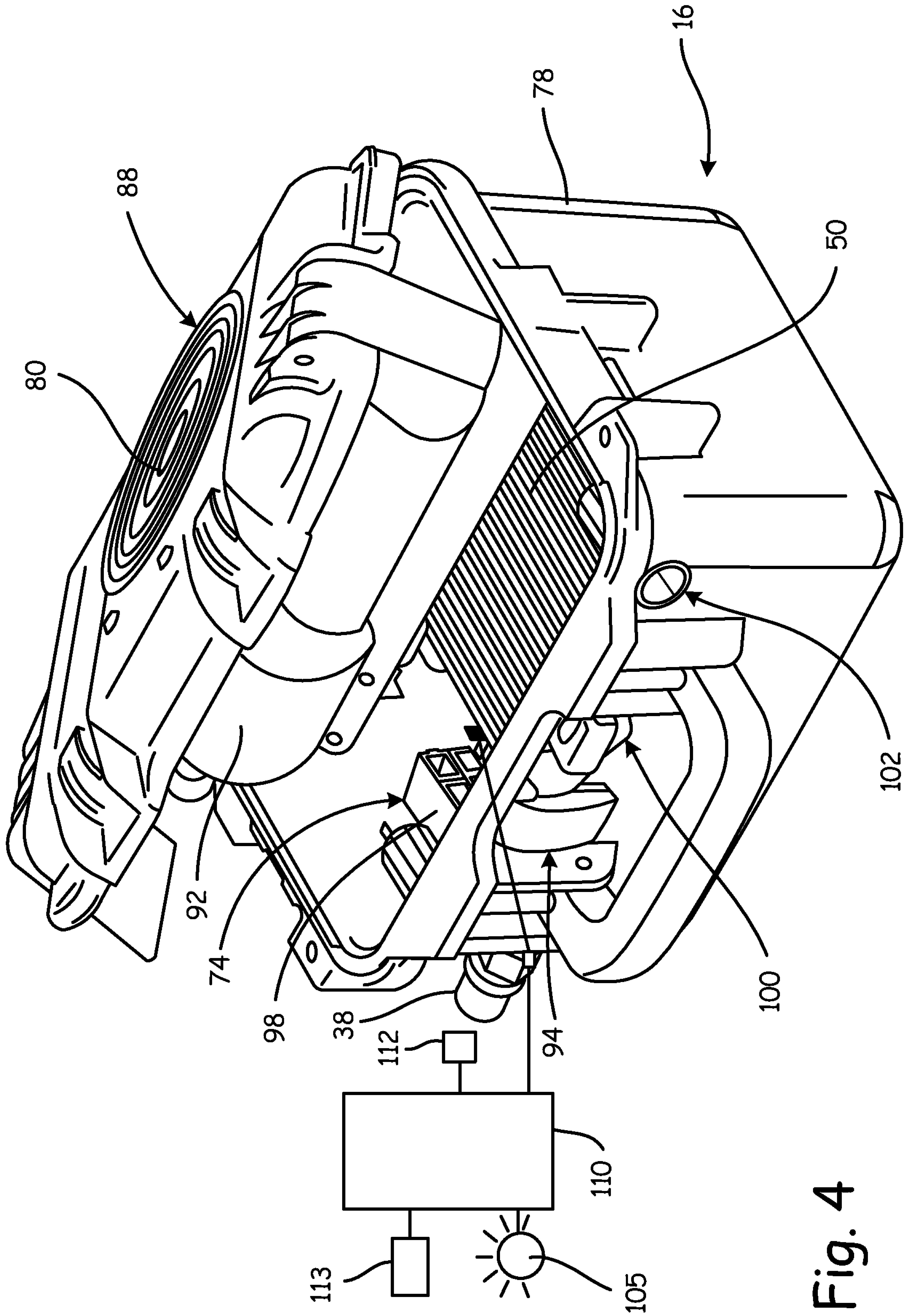

Fig. 4

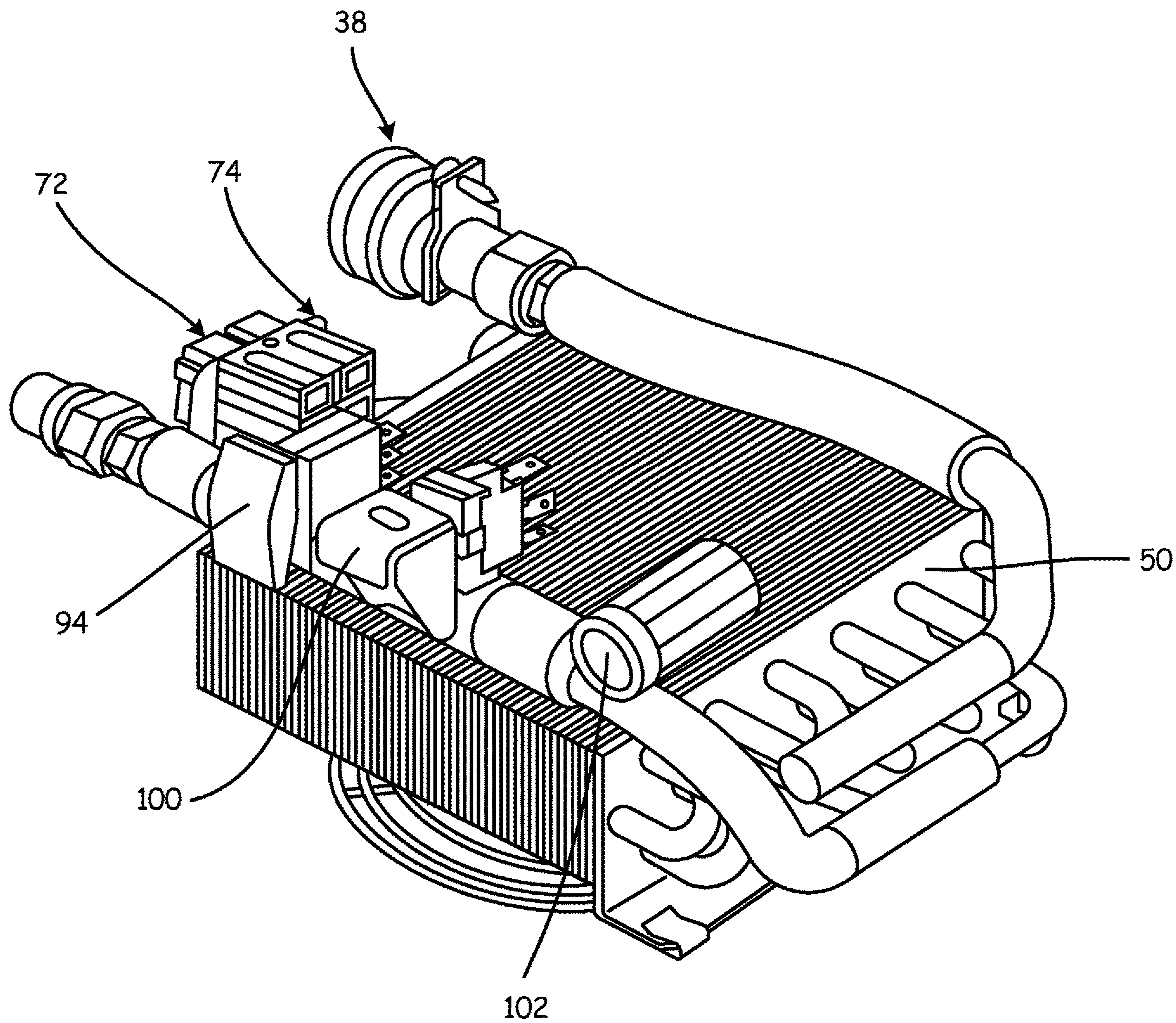

Fig. 5

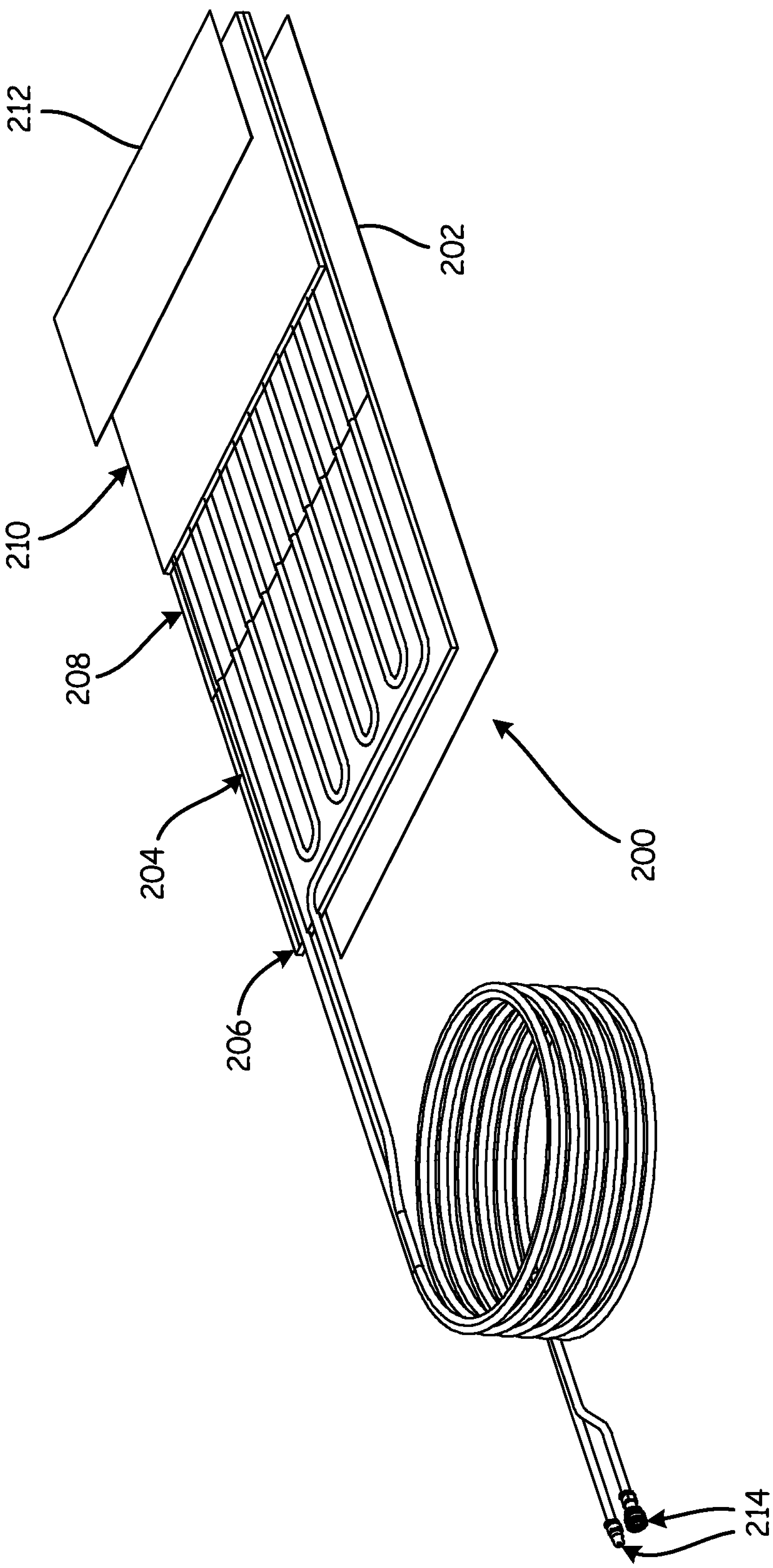

Fig. 6

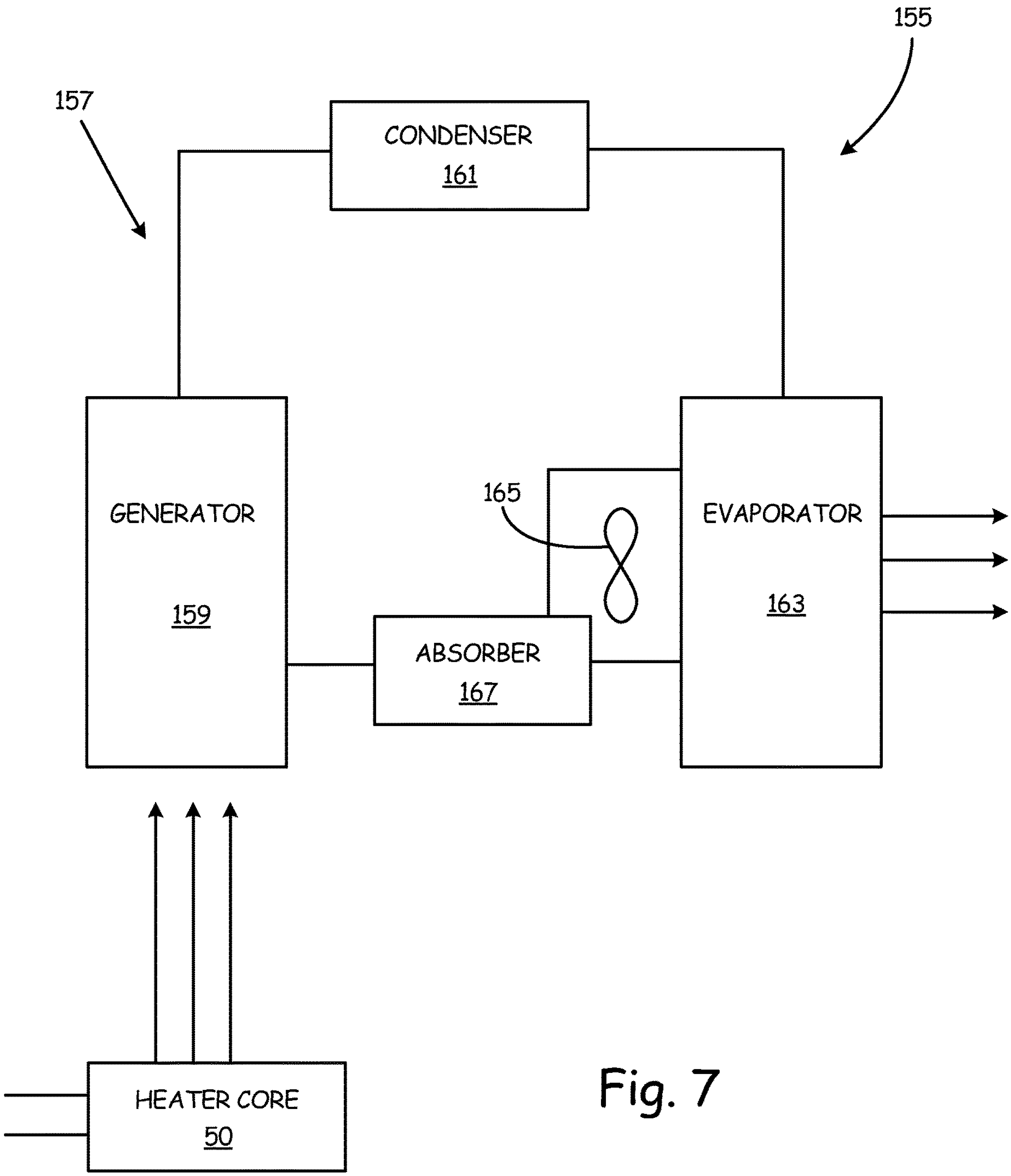
155
157
CONDENSER
161
GENERATOR
159
165
EVAPORATOR
163
ABSORBER
167
HEATER CORE
50

Fig. 7

APPARATUS AND METHOD OF WASTE ENERGY RECOVERY FROM A SOURCE OF HEATED FLUID

CROSS-REFERENCE TO RELATED APPLICATION

The present application claims the benefit of and priority to U.S. provisional patent application Ser. No. 62/053,133, filed Sep. 20, 2014, the content of which is hereby incorporated by reference in its entirety.

BACKGROUND

Liquid-cooled cooling systems for internal combustion engines to maintain the required temperature of the engine are well-known. The cooling system includes a radiator fluidly coupled to a pump, typically driven by the engine, the pump being fluidly connected to the engine block. Heated fluid from the engine block is circulated through the radiator by the pump. When the vehicle is stationary or traveling slowly such that sufficient air does not flow through the radiator, a fan driven by the engine or by an electric motor draws air through the radiator to transfer heat from the radiator to the air. It is also well known to provide a heater in the vehicle that generates heat for the vehicle compartment using the heated fluid from the engine block. Functionally, the heater is similar to that of the radiator described above in that a heater core is fluidly connected to the engine block or radiator. In many designs, the water pump used to provide flow through the engine block and the radiator is also used as a source of pressure to move coolant through the heater core as well. A fan is commonly provided to draw air through the heater core in order to heat the vehicle compartment.

In addition to the heater core described above to heat the vehicle compartment, other heating systems have been incorporated on vehicles to heat other portions of the vehicle using the heated fluid such as other portions of the vehicle compartment if the vehicle compartment is quite large, for example, in a camper or in an emergency vehicle like an ambulance.

SUMMARY

This Summary and the Abstract herein are provided to introduce a selection of concepts in a simplified form that are further described below in the Detailed Description. This Summary and the Abstract are not intended to identify key features or essential features of the claimed subject matter, nor are they intended to be used as an aid in determining the scope of the claimed subject matter. The claimed subject matter is not limited to implementations that solve any or all disadvantages noted in the background.

A first aspect of the disclosure is a system for recovering waste heat including an engine and a heater core connected to a source of fluid heated due to operation of the engine with fluid lines. One or more pumps connected to the heater core control fluid flow to the heater core. A control device connected to the one or more pumps is configured to operate the one or more pumps when the engine is not operating to circulate the fluid from the source of heated fluid through the heater core.

A second aspect of the disclosure is a portable heat recovery system having a heater core with a first pair of fluid coupling ends fluidly coupled to the heater core to circulate fluid therethrough and retain fluid therein when the first pair

of fluid coupling ends are connected to complementary ends. A cabling assembly is provided and includes a pair of fluid lines having first and second ends. A second pair of fluid coupling ends are connected to the first ends of the pair of fluid lines and configured to form a quick disconnect fluid transfer coupling with the first pair of fluid coupling ends. A third pair of fluid coupling ends are connected to the second ends of the pair of fluid lines and configured to form a quick disconnect fluid transfer coupling, wherein the second pair of coupling ends and the third pair coupling ends are configured to retain fluid in the lines when the second pair coupling ends and the third pair of coupling ends are disconnected from complementary ends.

One or more of the following features can be combined with the system and/or portable heat recovery system as desired. The source of fluid can comprise a coolant system of the engine or a separate fluid, for example, liquid isolated from the coolant system of the engine. The separate fluid. The portable heat recovery system can include one or more pumps, while either the portable heat recovery system or the system generally can further include a coupling assembly having a second pair of fluid lines configured to be connected to the source of heated fluid, and a fourth pair of fluid coupling ends fluidly connected to the first pair of fluid lines and removably connected to the third pair of fluid coupling ends. The coupling assembly can further comprise a housing wherein the one or more fluid pumps and/or the fourth pair of fluid coupling ends are mounted in or to the housing. One or more of the pumps can also be disposed in close proximity to the heater core, for example, disposed in an enclosure therefor.

The cabling assembly can house the fluid lines to the heater core and can be flexible and/or rigid as desired. An exterior sheath having an insulating material and/or a cut or wear resistant material can protect the fluid lines and electrical conductors, if provided, therein. The length of the cabling assembly can be so selected so as to be easily carried as a single unit. If desired, the cabling assembly can be formed from multiple, connected cabling segments allowing the length of the cabling assembly to be extended when necessary. Each cabling segment can be configured with identical ends allowing the cabling segments to be connected to one another or to the coupling assembly and/or the heater core.

The heater core can be disposed in an enclosure comprising for example a box having rigid walls or a blanket having flexible sheets form the walls of the enclosure. If desired, the enclosure can include apertures for airflow therethrough. A blower can be mounted in the enclosure and configured to blow air through the apertures and an electrical connector is connected to the blower.

Various forms of control devices can be provided to control the one or more pumps and/or the blower. The control devices can comprise switches, for example but not limited to, mounted to the enclosure. In another embodiment, the control device comprises a controller again that can be mounted in or to the enclosure or separately therefrom. The control device can receive an input from a temperature sensor operably connected to the fluid flowing through the heater core and/or a pressure sensor measuring pressure of the fluid, wherein the control device is configured to provide outputs indicative of temperature and/or pressure of the fluid. The control device can have one or more outputs to control operation of the one or more fluid pumps, valves that can stop fluid flow and/or start and stop the engine based on the temperature and/or pressure of the fluid.

As indicated above, the heater core can be portable, but also can be fixed or secured to a structure such as a building or another portion of a vehicle (or a trailer connected thereto) to be carried therewith. In addition to providing heat to heat an enclosure or object, if desired, a cooling assembly such as adsorption cooler assembly can be operatively coupled to the heater core to use the heat therefrom to cool an enclosure or object.

Another aspect is a method of recovering waste heat from an engine when the engine is not operating. The method includes connecting a heater core to source of fluid heated due to operation of the engine with fluid lines, the flow of fluid from the source of heated fluid controlled by one or more pumps, and operating the pumps when the engine is not operating to circulate the fluid from the source of heated fluid through the heater core. Any of the features described above can be included in the method in other embodiments.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is an exemplary embodiment of a waste heat recovery system.

FIG. **2** is a schematic illustration of the waste heat recovery system.

FIG. **3** is a perspective view of a coupling assembly.

FIG. **4** is a perspective view of a portable heat recovery system.

FIG. **5** is a perspective view of the portable heat recovery system with portions removed.

FIG. **6** is a schematic representation of a heating blanket.

FIG. **7** is a schematic representation of a cooling unit.

DETAILED DESCRIPTION OF ILLUSTRATIVE EMBODIMENT

FIG. **1** illustrates a portable waste heat recovery system **10** that can be selectively fluidly connected to a heated fluid source such as a cooling system of any liquid cooled engine or other device or machine having heated fluid. In the exemplary and particularly advantageous embodiment, the heated fluid source is a vehicle **11** having an internal combustion engine. Although described for use with the vehicle **11**, this should not be considered limiting, but rather representative of a heated fluid source. The portable system **10** can be selectively fluidly connected to the cooling system of the vehicle **11**, and in a particularly advantageous embodiment through a cabling assembly **12**, preferably flexible for ease of carrying, that allows the system **10** to provide heat at a location quite remote from the vehicle **11** such as but not limited to 15-50 feet from the vehicle **11** using a heater **16**. When not in use, the system **10** can be stored in an area or volume that is quite small due to the compact nature of the heater **16** and the cabling assembly **12**. Due to the fact that the system **10** can provide large quantities of heat at a long distance from the vehicle **11**, the vehicle **11** can then be located at a safe distance away from a the structure or area to be heated so that exhaust fumes from the vehicle **11** when the engine is running are less likely to be present in the structure or area to be heated. For instance, the system **10** can be deployed in an ice fishing house or garage **18**, schematically illustrated by dashed lines, in order to heat the interior of the ice fishing house or garage **18** while the vehicle **11** remains outside.

FIG. **2** is a schematic illustration of the system **10** as connected to the vehicle **11** represented in FIG. **2** only by an engine **20**, radiator **22**, battery **24** and heater core **26**. The system **10** further includes a coupling assembly **30**, typically mounted to the vehicle **11** to travel with the vehicle **11**. The coupling assembly **30** includes quick disconnect couplers **38** having coupling ends **34** that mate with complementary coupling ends **36** provided on the cabling assembly **12** to provide a quick disconnection capability. Such quick disconnect couplers **38** are well known. An electrical power connector **37** from the vehicle **11** to the heater **16** is also provided so as to provide an electrical connection through the cabling assembly **12** for power and/or other electrical signals provided to and/or obtained from heater **16**. Quick disconnect couplers **38**, which can be the same or similar to couplers having ends **34**, **36** are used between the cabling assembly **12** and the heater **16** in addition to an electrical connector **40** so that the cabling assembly **12** can be both disconnected from the heater **16** as well as the coupling assembly **30**. In this manner, the cabling assembly **12** and the heater **16** can be carried and stored separately, and preferably with fluid lines **46** used to provide coolant from the vehicle **11** to the heater **16** that remain filled with coolant after disconnection of the fluid lines **46** from both the coupling assembly **30** and the heater **16**. In this manner, introduction of air into the cooling system of the engine is prevented, or at least minimized.

A heater core **50** (FIGS. **4** and **5**) is also provided in the heater **16** and retains fluid therein when the fluid lines **46** cabling assembly **12** are disconnected, again, to prevent or at least minimize introduction of air into the cooling system. The quick disconnection couplers **38** provided between the cabling assembly **12** and the heater **16** are particularly advantageous in view that the cabling assembly **12** has fluid contained therein, which adds to the weight of the cabling assembly **12** and if quick disconnect couplers were not provided and the lines **46** were to remain fixedly connected to the heater **16**, mishandling of the cabling assembly **12** could cause damage to the fluid connections to the heater **16**.

In one embodiment, the cabling assembly **12** can include a flexible protective sheath **13** that is heat, wear and/or cut resistance. The sheath **13** conveniently retains all of the coolant and electrical lines between the coupling assembly **30** and the heater **16** so as to be carried a single unit and provide protection as well as convenient handling. At this point it should be noted that if desired, the cabling assembly **12** extending between the coupling assembly **30** and the heater **16** can be formed from a plurality of cabling segments connected together (illustrated schematically in FIG. **1** as cabling segments **12'** and **12"**) with preferably quick disconnect couplers **38** and electrical connector **40** as described above and suitable electrical connectors. In this manner, the overall length of the cabling assembly **12** can be extended as long as desired, limited practically by the acceptable heat loss that may occur due to the length of the cabling assembly **12** in the operating environment. In one embodiment, one or more of cabling segments **12'**, **12"** etc. would each be of length such that the weight of the cabling segment is of convenient weight to be hand carried such as but not limited to 15 to 40 pounds. However, it should be noted in another embodiment, the cabling assembly **12** and/or cabling segments **12'**, **12"** can be carried by and deployed using a reel assembly, not shown.

As indicated above, the coupling assembly **30** provides electrical power to the heater **16**. Electrical connection of the coupling assembly **30** to the vehicle **11** is represented schematically in FIG. **2** by lines **52** forming a direct connection to the battery **24**. Although such a connection could be used, a suitable connection to any portion of the electrical system of the vehicle **11** should be understood. Likewise, although not illustrated, the electrical connection can be protected with a fuse or breaker mounted in the vehicle **11**, the coupling assembly **30**, and/or the heater **16**.

Coolant lines **56** connect the coupling assembly **30** to the cooling system of the vehicle **11**. Such a connection can be at any convenient location on the vehicle **11**. In the embodiment illustrated in FIG. **2**, the lines **56** can be connected to the radiator hose as represented by lines **58**, directly to portions or fixtures on the engine **20** as represented by lines **60** and/or to the lines providing coolant to the vehicle heater core **26** as represented by lines **64**, or combinations thereof as desired.

At this point it should be noted that the heated fluid source of a vehicle is not limited to the cooling system, but can be a heat exchanger **67** that extracts waste heat from the exhaust system of the engine. Commonly, fluid lines **69** of the heat exchanger **67** are directly connected to or are fluid lines **59** since the heat exchanger **67** is typically an isolated or independent of the cooling system. Again, other forms of heated fluid sources can be used other than the exemplary embodiments described herein.

Referring to the enlarged illustration of the coupling assembly **30** in FIG. **3**, the coupling assembly **30** includes a housing **31** configured to be mounted to the vehicle **11**. Circulating pump(s) **70** are mounted to the housing **31** and are fluidly connected and disposed between the quick disconnect couplers **38** provided on the coupling assembly **30** and the coolant lines **56**. The circulating pump(s) **70** can be a single speed or a variable speed motor. Electrical connectors **72** are provided on the coupling assembly **30** that connect to the electrical wires **57** provided in the cabling assembly **12** to allow control of pump(s) **70** from the heater **16**. Connectors **72** are used to provide power and/or other electrical signals to the heater **16**. It should be noted the pump(s) **70** are different than the water pump of the engine that circulates coolant throughout the engine and to a radiator connected thereto. The pump(s) **70** exclusively or directly control fluid flow from the source of heated fluid to the heater core **50**, wherein if the source of heated fluid is the coolant heated by the engine, the pump(s) **70** and not the water pump of the engine **20** control fluid flow to the heater core **50**. As explained below, the pump(s) **70** operate when the engine **20** is in many instances not running.

FIGS. **4** and **5** provide an enlarged view of the heater **16** and components mounted therein, respectively. Generally, in one embodiment, a rugged enclosure **78** such as manufactured by Pelican Products, Inc. of Tempe, Ariz. or Seahorse Protective Equipment Cases of La Verne, Calif. houses the components of the heater **16** and includes apertures **80** and **82** (FIG. **1**) to allow airflow through the enclosure **78**. In the embodiment illustrated, at least one aperture **80** is provided on a lid **88** while at least one aperture **82** is provided on the side of the enclosure **78** opposite the first aperture **80**; however, it should be understood that this is but one embodiment. A handle **81** (FIG. **1**) allows the heater **16** to be easily carried, although or other recesses configured to enable the heater **16** to be carried can be used and are equivalent to the handle **81**.

The heater core **50** and a blower **92** are mounted in the enclosure **68**, and in the embodiment illustrated, the blower **92** is mounted to the lid **88** to be in fluid communication with aperture **80**, while the heater core **50** is mounted to an inner surface of the enclosure **68** proximate the aperture **82**. An electrical switch **94** selectively provides power from the electrical connector **74** to the blower **92** which can include a single speed, multi-speed or variable speed electric motor. The connectors **72** of the coupling assembly **30** connect wires provided in the cable assembly **12** that in turn are connected to connector **98**, which are connected to electrical switch **100**. Electrical switch **100** allows the pump(s) **70** to be remotely turned off at the heater **16** if desired. A cigarette lighter receptacle **102** can be provided if desired so that electrical devices such as but not limited to lights, entertainment equipment, power converters, can be powered remotely from the vehicle **11** using the electrical power available on the vehicle **11**.

It has been found that significant efficiency of the system **10** is obtained with controlled flow of coolant from the vehicle **11** and through the heater core **50**. Without specific control such as if the coolant lines **56** are fluidly connected to the cooling system of the vehicle **11** and the water pump of the engine **20** is used to move coolant through the heater **16**, the amount of heat generated remotely is very low. Instead, pump(s) **70** control fluid flow through the heater **16**. It has been discovered that fluid flow of 3-12 gallons per minute, and more preferably 5-9 gallons per minute, and yet more preferably 6-8 gallons per minute is particularly advantageous because the heater **16** can be used with a wide variety of engine sizes for example, from, for example, 500 cc or less through engines typically found in vehicles such as 1.4 liter to 8.3 liters and even larger engines. In addition, it has been discovered that a flow rate of 6-8 gallons per minute, and in particular, a fluid flow of about 7 gallons per minute has been found to be optimal even when different heaters that vary in output, for example, a 20,000 BTU output, 40,000 BTU output and 80,000 BTU output are connected to the coupling assembly **30**. In each of these versions, the same enclosure **68** can be used with different heater cores **50** mounted in the enclosure **68**. In operation, the pre-charged coolant lines (i.e. filled with coolant) and the electrical lines of the cable assembly **12** are connected both to the coupling assembly **30** and to the heater **16**. The switch **94** on the enclosure **68** when operated activates the blower **92** to move air through the heater core **50**. Switch **100** is operated to power the pump(s) **70** to supply the heater core **50** with coolant from the vehicle **11**, which, for example, typically varies from 125 to 225 degrees. At 7 gallons per minute and 150 degree coolant supply from the vehicle, the heater **16** using an insulated cable assembly **12** of 25-50 feet can deliver approximately 135 degrees of hot air in an environment having an ambient air temperature of 10 degrees.

In further embodiment, a thermostat controlled circuit represented at **110** but suitably mounted in the enclosure **68** can be operably connected to the blower **92** and/or the pump(s) **70**. The thermostat controlled circuit **110** includes a user operated input device such as but not limited to a rotatable knob **105** having a scale indicating a desired temperature. A temperature sensor **112**, for example, mounted to the enclosure **78** measures the ambient temperature in the structure. A digital readout device **113** can be included in circuit **110** and mounted to enclosure **68** to indicate the current ambient temperature. In another embodiment, setting of the desired ambient temperature can be digitally displayed and adjusted with suitable user operated buttons or switches connected to circuit **110**.

In many instances, the coolant temperature from the vehicle **11** will be sufficient to operate the heater **16** for at least some period of time without the vehicle **11** running. A control circuit represented at **114** in FIG. **3** can be suitably mounted in the housing of coupling assembly **30** (or in enclosure **68**) and receives as an input, the temperature of the coolant, for example, as measured at the coupling assembly **30** by temperature sensor **117**. When the coolant temperature falls below a selected temperature, the control circuit **114** can provide an output command represented at **116** to start the vehicle **11**. Devices for allowing remote starting of the vehicle **11** are well known and are not pertinent to the present invention, thus, will not be further discussed. Once the coolant temperature reaches a higher second selected temperature, possibly after a selected time period of engine **20** operation, the control circuit **114** can provide an output command to shut the engine **20** off.

Depending on the heating capabilities of the heater **16**, and the coolant capacity of the cooling system of the vehicle **11**, which commonly is based on the size of the engine, the heater **16** could potentially remove too much heat from the cooling system thereby lowering the coolant temperature, and thus the engine below a desired operating temperature of the engine manufacturer. As indicated above, the control circuit **114** can monitor the coolant temperature. If the coolant temperature falls below a selected temperature with the engine **20** running, it may be indicative of the heater **16** removing too much heat from the cooling system. In such a case, the control circuit **114** can control operation of the blower **92** and/or the pump(s) **70** to control the amount of heat withdrawn from the heater core **50** or the amount of coolant provided to the heater **16**, respectively. The control circuit **114** can be configured to take one or more of the following actions which include: turning off the pump(s) **70** and/or the blower **92**, or reducing the speed thereof until the temperature of the coolant rises to a selected temperature. The control circuit **114** can also be configured to intermittently operate either the pump(s) **70** and/or the blower **92**. The control circuit **114** can also be configured if desired to inhibit coolant flow to the heater **16** by turning off the pumps **70** or operating valve(s) **120** fluidly connected so as to selectively inhibit fluid flow. The valves **120** shown schematically can be controlled electrically such as through a solenoid operated valve. It should be noted that the control circuit **114** receives an input signal **121** from the engine, vehicle or a sensor indicative of whether the engine is running. For example, a sensor that detects whether a component of the engine is rotating via a proximity sensor can be used. In another embodiment, the sensor can be an audio sensor to sense when the engine is running.

In a further embodiment, pressure sensors schematically illustrated at **127** can be provided to measure the pressure in one or both of the fluid lines connecting the coupling assembly **30** to the heater **16**. The signals indicative of the measured pressure are provided to the control circuit **114**. The control circuit **114** can shut off the pump(s) **70** and/or operate the valves **120** to inhibit fluid flow through the system if the pressure falls below a selected threshold, which could indicate that there exists a coolant leak in the system between or in the coupling assembly **30** and the heater **16**.

It should be noted that aspects of the waste heat recovery system **10** are not limited to only portable applications. Rather, as illustrated in FIG. **2** components of the system **10** can be utilized in other applications. For example, a heater **16'** and in particular a heater core **50'** can be fluidly coupled to the source of heated fluid without quick disconnect couplings such as the case where the heater core **50'** may be fluidly coupled to a stationary engine with the heater core **50'** fixedly mounted or otherwise disposed in the stationary structure **18** schematically illustrated in FIG. **1**. In such an application fluid lines connecting the heater core **50** to the pump(s) **70** and the fluid lines **129** from the pump(s) **70** to the engine **20** and fluid lines **131** from the pump(s) to the heater core **50'** may be rigid rather than disposed in a flexible cabling assembly **12** with or without electrical conductors providing power to the blower **92** or other electrical components associated with the heater core **50'**. The control circuit **114**, other control devices like switches or the like (not shown in FIG. **2**), can be located as desired, for example on an inner wall of the structure **18**.

In another application also illustrated by the schematic drawing of FIG. **2**, the heater core **50'** can be mounted in another portion of the vehicle having the engine **20**, or mounted in a trailer or the like pulled by the vehicle having the engine **20** such as the case in a tractor trailer application. In the latter application, the coupling assembly **30** can be mounted to the tractor, while the flexible cabling assembly **12** couples the heater core **50** to the components mounted to the tractor. The control circuit **114** can be, for example, located in the trailer with the heater core **50**, disposed in the tractor or integrated as part of the control system of the tractor.

Although in operation the heater core **50** provides heat to a selected location remote from the source of heated fluid such as the coolant system of the engine **20**, it should be noted providing heat to increase or maintain the temperature of a structure **18** or other portion of a vehicle or trailer connected thereto need not be its sole function. Referring to FIG. **7**, the heater core **50** can be used to provide cooling such as provided by an air conditioning or refrigeration unit schematically represented at **155**. Generally, the heater core **150** provides heat that can be used by a cooling assembly **157** such as an absorption cooling assembly herein illustrated by way of example. The heater core **50** and cooling assembly **157** can be disposed in a portable enclosure movable due to the flexibility of the cabling assembly **12** or be mounted in a fixed location on the vehicle or other structure. Components and operation of an air conditioning or refrigeration unit utilizing an absorption cooling assembly are well known and are only briefly described herein since the specific components and operation are not necessary for understanding application of aspects of the present invention to this application.

Generally, the cooling or refrigeration process starts with a generator **159** having a liquid by way of example water containing dissolved ammonia (or other form of liquid including water, salt water, propane, water-lithium bromide, etc.). The heater core **50** heats the generator **159** until it reaches the boiling point of ammonia. Since ammonia boils at a lower temperature than water does, the ammonia leaves the generator **159** and moves into a condenser **161**. In the condenser **161**, the ammonia starts to cool and eventually forms liquid ammonia. The ammonia flows down from the condenser **161** into a hydrogen-filled chamber or evaporator **163**. In the low-pressure chamber of the evaporator **163**, the ammonia expands, cooling rapidly as it does. A fan or blower **165** blows on the evaporator **163**, cooling down the air as it blows past. The cold air is circulated through to the location to be cooled. An absorber **167** provides water through the evaporator **163**. Ammonia dissolves easily in water, but hydrogen does not. The water with the dissolved ammonia flows back to the generator, starting the cycle all over again. In addition to cooling, the heater core **50** can also be operated if desired to provide heat to the location rather than cooling through use of the cooling assembly **157**.

In another embodiment illustrated in FIG. **6**, the system can comprise an insulated heating blanket **200** that is convenient for example and without limitation to melt snow, thaw a selected area of the ground and/or be used as an aid in curing concrete. The blanket **200** can be of a multi-layered enclosure, preferably flexible, having a conductive outer layer **202** for conducting heat from a heater core comprising a hose **204** to the surface to be heated. A suitable conductive layer for example can comprise silver cross woven polyethylene **202**. A flexible layer **206** can be provided to help support the hose **204** with portions typically spaced apart and distributed throughout the blanket **200** and maintain the portion in positions so as not to bunch up. The flexible layer **206** can be a heat conductive or a light insulating layer. A high-density bubble layer may be used as layer **206**. A heat reflective layer **208** directs heat from hose downwardly toward layer **202**. The heat reflectively layer **208** can be, for example, made of aluminum. A high insulating layer **210** on a side of the reflective layer **208** opposite layer **202** helps minimize heat loss upwardly and can for example be a high-density closed cell foam layer. An outer protective layer **212** is provided and secured for example to outer layer **202**. A suitable material for outer protective layer **212** can comprise cross woven polyethylene, which can be of a dark color such as black. Quick disconnect couplers **214** identical to those used on the heater **16** can be provided so as to allow the cabling assembly **12** to be used with the heating blanket **200**. Like the heater **16**, the disconnect couplers **214** retain coolant in the hose **204** when the couplers are disconnected from the cable assembly **12** (i.e. pre-charged) so as to minimize or prevent air from entering the cooling system of when not in use.

The system components herein described, i.e. the heater **16**, the cabling assembly **12**, the coupling assembly **30** and heating blanket provide a user a lot of flexibility to heat an area or structure using one or more heated fluid sources. For example, a user can equip two or more heated fluid sources such as two or more vehicles, stationary engines such as used with electrical generators, or the like each with a coupling assembly **30**. In this manner, the user can use cable assembly **12** and the heater **16** or heating blanket with any of the heated fluid sources as desired. For example, the user could equip an automobile or truck with one coupling assembly **30** and an all terrain vehicle (ATV) with another coupling assembly **30**. The user can then use the same heater or heating blanket with either vehicle. As discussed above, the control circuit **114** can monitor the coolant temperature such that the heat withdrawn from the vehicle does not cause the temperature to fall below the manufactures desired operating range.

In another application, the user can have multiple heaters **16** and/or heating blankets with different output capabilities. In this manner, the user can select a heater **16** or heating blanket that meets the user's situation. For example, if a small structure is to be heated a lower output heater **16** can be used, while if a larger structure must be heated, a heater **16** with higher output capabilities could then be used.

Although the subject matter has been described in language specific to structural features and/or methodological acts, it is to be understood that the subject matter defined in the appended claims is not necessarily limited to the specific features or acts described above as has been determined by the courts. Rather, the specific features and acts described above are disclosed as example forms of implementing the claims.

What is claimed is:

1. A portable heat recovery system to recovery heat from an internal combustion engine of a vehicle having a cooling system with a water pump for cooling fluid of the internal combustion engine, comprising:

an enclosure having apertures for airflow;

a heater core mounted in the enclosure;

a blower mounted in the enclosure and configured to blow air through the heater core and the apertures;

a first pair of fluid coupling ends fluidly coupled to the heater core to circulate fluid therethrough and retain the cooling fluid therein when not connected to complementary ends;

a cabling assembly including:

a pair of fluid lines having first and second ends;

a second pair of fluid coupling ends connected to the first ends of the pair of fluid lines and configured to form a quick disconnect fluid transfer coupling with the first pair of fluid coupling ends; a third pair of fluid coupling ends connected to the second ends of the pair of fluid lines and configured to form a quick disconnect fluid transfer coupling, wherein the second pair of fluid coupling ends and the third pair of fluid coupling ends are configured to retain the cooling fluid in the pair of fluid lines when the second pair of fluid coupling ends and the third pair of fluid coupling ends are disconnected from each other;

a pair of electrical conductors having first conductor ends at the first ends of the pair of fluid lines and second conductor ends at the second ends of the pair of fluid lines, the first conductor ends electrically connected to the blower;

an exterior sheath securing the pair of fluid lines and electrical conductors therein so as to be carried as a single unit;

one or more fluid pumps configured for mounting to the vehicle to travel therewith, the one or more fluid pumps being separate from the water pump, the one or more fluid pumps fluidly connected to the pair of fluid lines and to the heater core and configured to circulate the cooling fluid therethrough;

a coupling assembly configured for mounting to the vehicle to travel therewith, the coupling assembly including:

a second pair of fluid lines configured to be connected to the cooling system to receive the cooling fluid, the second pair of fluid lines having first cooling system ends configured to be connected to the cooling system to receive the cooling fluid and second cooling system ends opposite the first cooling system ends;

a fourth pair of fluid coupling ends fluidly and removably connected to the third pair of fluid coupling ends; and

one or more valves fluidly coupled to the second cooling system ends, the one or more valves being fluidly connected to the fourth pair of fluid coupling ends between the second cooling system ends and the fourth pair of fluid coupling ends, the one or more valves being selectively operable to stop flow of the cooling fluid through the fourth pair of fluid coupling ends;

a temperature sensor operably connected to the cooling fluid flowing through the heater core and configured to provide an output indicative of temperature of the cooling fluid;

a housing mountable to the vehicle to travel with the vehicle; and

a control device disposed in the housing and operably connected to the one or more valves and configured to receive an input indicative of a leak in the flow of the cooling fluid to the heater core and operate the one or more valves to stop the flow of the cooling fluid through the fourth pair of fluid coupling ends based on the input, the control device being connected to the temperature sensor to receive the output indicative of temperature, the control device being configured to operate the one or more fluid pumps based on the output indicative of temperature, and the control device being further configured to operate the one or more fluid pumps when the water pump is not operating to circulate the cooling fluid and control the flow of the cooling fluid from the cooling system through the heater core.

2. The portable heat recovery system of claim 1 wherein the one or more fluid pumps are mounted in the housing.

3. The portable heat recovery system of claim 1 wherein the cabling assembly comprises removably connectable segments, each segment having fluid lines, electrical conductors and connectors to selectively connect the electrical conductors of different segments together, wherein a portion of each connector is proximate each of the ends of the pair of fluid lines in each segment.

4. A system for recovering waste heat, the system comprising

an engine configured to create a source of heated fluid;

engine fluid couplings configured to circulate fluid therethrough and retain fluid in the source of heated fluid when not connected to complementary ends;

a heater core mounted in an enclosure;

a first pair of fluid coupling ends fluidly coupled to the heater core to circulate fluid therethrough and retain the fluid therein when not connected to a set of complementary ends;

a cabling assembly including:

a pair of fluid lines having first and second ends;

a second pair of fluid coupling ends connected to the first ends of the pair of fluid lines and configured to form a quick disconnect fluid transfer coupling with the first pair of fluid coupling ends;

a third pair of fluid coupling ends connected to the second ends of the pair of fluid lines and configured to form a quick disconnect fluid transfer coupling with the source fluid coupling ends, wherein the second pair of fluid coupling ends and the third pair of fluid coupling ends are configured to retain the fluid in the pair of fluid lines when the second pair of fluid coupling ends and the third pair of fluid coupling ends are disconnected from each other;

one or more pumps connected to the heater core to control fluid flow to the heater core;

a coupling assembly including:

a second pair of fluid lines configured to be connected to the source of heated fluid to receive the fluid, the second pair of fluid lines having first system ends configured to be connected to the source of heated fluid to receive the fluid and second system ends opposite the first system ends, the source fluid coupling ends being fluidly and removably connected to the third pair of fluid coupling ends; and

a fourth pair of fluid coupling ends fluidly and removably connected to the third pair of fluid coupling ends; and

one or more valves fluidly coupled to the second system ends, the one or more valves being fluidly connected to the source fluid coupling ends between the second system ends and the source fluid coupling ends, the one or more valves being selectively operable to stop flow of the fluid through the source fluid coupling ends;

a temperature sensor operably connected to the fluid flowing through the heater core and configured to provide an output indicative of temperature of the fluid; and

a housing having a control device operably connected to the one or more valves and configured to receive an input indicative of a leak in the flow of the fluid to the heater core and operate the one or more valves to stop the flow of the fluid through the source fluid coupling ends based on the input, the control device being connected to the temperature sensor to receive the output indicative of temperature, the control device being configured to operate the one or more pumps based on the output indicative of temperature, and the control device being further configured to operate the one or more pumps when the engine is not operating to circulate the flow of the fluid from the source of heated fluid through the heater core at a flow rate of 3-12 gallons per minute.

5. The system of claim 4 wherein the enclosure has apertures for airflow therethrough, a blower mounted in the enclosure and configured to blow air through the apertures, and wherein the engine includes a battery and the cabling assembly includes electrical conductors connecting the battery to the blower.

6. The portable heat recovery system of claim 1 wherein the enclosure includes first switch connected to the blower and a second switch electrically connected to the one or more fluid pumps, and wherein the one or more fluid pumps are remote from the enclosure and an electrical conductor is provided in the cabling assembly to electrically connect the second switch to the one or more fluid pumps.

7. The portable heat recovery system of claim 1 wherein the control device includes another output configured to control the engine so as to start and stop the engine generating heated cooling fluid based on the output from the temperature sensor.

8. The portable heat recovery system of claim 1 and further comprising a pressure sensor configured to provide an output indicative of pressure of the cooling fluid in the cabling assembly to the control device.

9. A method of recovering waste heat from an engine of a vehicle that creates a source of heated fluid due to operation of the engine, the engine having a cooling system with a water pump for circulating fluid in the engine when the engine is operating, a battery and engine fluid coupling ends to circulate fluid therethrough and retain fluid in the source of heated fluid when not connected to complementary ends, the method of recovering waste heat occurring when the engine is not operating, the method comprising;

providing a heater assembly comprising:

an enclosure having apertures for airflow;

a heater core mounted in the enclosure;

a blower mounted in the enclosure and configured to blow air through the heater core and the apertures;

a first pair of fluid coupling ends fluidly coupled to the heater core to circulate fluid therethrough and retain fluid therein when not connected to fluid coupling complementary ends;

a cabling assembly including:

a pair of fluid lines having first and second ends;

a second pair of fluid coupling ends connected to the first ends of the pair of fluid lines and configured to form a quick disconnect fluid transfer coupling with the first pair of fluid coupling ends;

a third pair of fluid coupling ends connected to the second ends of the pair of fluid lines and configured to form a quick disconnect fluid transfer coupling, wherein the second pair of fluid coupling ends and the third pair of fluid coupling ends are configured to retain the fluid in the pair of fluid lines when the second pair of fluid coupling ends and the third pair of fluid coupling ends are disconnected from each other;

a pair of electrical conductors having first conductor ends at the first ends of the pair of fluid lines and second conductor ends at the second ends of the pair of fluid lines, the first conductor ends electrically connected to the blower;

an exterior sheath securing the pair of fluid lines and electrical conductors therein so as to be carried a single unit; and a pump, separate from the water pump, fluidly connected to the pair of fluid lines and to the heater core and configured to circulate fluid therethrough;

a coupling assembly including:

a second pair of fluid lines configured to be connected to the source of heated fluid to receive the fluid, the second pair of fluid lines having first system ends configured to be connected to the source of heated fluid to receive the fluid and second system ends opposite the first system ends fluidly coupled to the engine fluid coupling ends, the engine fluid coupling ends being fluidly and removably connected to the third pair of fluid coupling ends; and

one or more valves fluidly coupled to the second system ends, the one or more valves being fluidly connected to the engine fluid coupling ends between the second system ends and the engine fluid coupling ends, the one or more valves being selectively operable to stop flow of the fluid through the engine fluid coupling ends;

a temperature sensor operably connected to the fluid flowing through the heater core and configured to provide an output indicative of temperature of the fluid;

a housing having a control device operably connected to the pump, the one or more valves and the temperature sensor;

mounting the pump, the coupling assembly and the housing to the vehicle for travel with the vehicle;

connecting the second pair of fluid coupling ends with the first pair of fluid coupling ends;

connecting the third pair of fluid coupling ends with the engine fluid coupling ends;

connecting the second conductor ends to the battery so as to provide power to the blower;

controlling the one or move valves with the control device based on an input indicative of a leak in the flow of the fluid to the heater core; and

controlling the pump with the control device when the engine is not operating to control flow of the fluid from the source of heated fluid through the heater core at a flow rate of 3-12 gallons per minute, wherein controlling includes controlling the pump based on the output indicative of temperature of the fluid from the temperature sensor.

10. The method of claim **9** wherein the heater core receives coolant fluid used to cool the engine during operation, and wherein connecting the second pair of fluid coupling ends with the first pair of fluid coupling ends and connecting the third pair of fluid coupling ends with the engine fluid coupling ends causes direct circulation of fluid from the heater core into the engine.

11. The method of claim **9** wherein the heater core receives fluid from a heat exchanger having fluid that is separate from coolant fluid used to cool the engine during operation, and wherein connecting the second pair of fluid coupling ends with the first pair of fluid coupling ends and connecting the third pair of fluid coupling ends with the engine fluid coupling ends causes direct circulation of fluid between from the heater core into the heat exchanger.

12. The method of claim **9** and further comprising;

measuring a temperature of the fluid provided to or through the heater core; and

operating the engine to heat the source of heated fluid when the temperature of the fluid falls below a selected temperature and turning the engine off when the source of heated fluid reaches a selected temperature.

13. The system of claim **4** wherein the enclosure comprises a blanket.

14. The system of claim **4** wherein the source of heated fluid comprises a coolant system of the engine.

15. The system of claim **14** wherein the control device is configured to provide an output configured to control operation of the engine based on the temperature of the fluid.

16. The system of claim **15** wherein the engine is on a vehicle.

17. The system of claim **4** and further comprising a cooling assembly operably coupled to the heater core to receive heat therefrom, the cooling assembly comprising a generator configured to receive the heat and heat cooling fluid, an evaporator connected to the generator to receive heated cooling fluid and cool the cooling fluid to a liquid that is returned to the generator; and a blower configured to blow air on the evaporator.

18. The method of claim **9** and further comprising locating the enclosure in a structure that is remote from the engine and controlling comprises controlling at least one of the pump and the blower to control a temperature in the structure.

19. The method of claim **10** and further comprising selectively turning the engine on based on the temperature of the fluid through the heater core.

20. The method of claim **19** and further comprising selectively turning off the engine based on the temperature of the fluid through the heater core.

21. The method of claim **18** and further providing a cooling assembly operably coupled to the heater core to receive heat therefrom, the cooling assembly comprising a generator configured to receive the heat and heat cooling fluid, an evaporator connected to the generator to receive heated cooling fluid and cool the cooling fluid to a liquid that is returned to the generator; and an evaporator blower configured to blow air on the evaporator, and wherein controlling the temperature in the structure comprises cooling an inside of the structure.

22. The method of claim **18** wherein controlling the temperature in the structure comprises heating an inside of the structure.

23. The portable heat recovery system of claim **1** wherein the one or more valves comprise a first valve fluidly coupled to a first fluid coupling end of the fourth pair of fluid coupling ends and a second valve fluidly coupled to a second fluid coupling end of the fourth pair of fluid coupling ends.

24. The portable heat recovery system of claim **23** wherein the first valve and the second valve are mounted in the housing.

25. The portable heat recovery system of claim 24 wherein the fourth pair of fluid coupling ends are mounted to the housing.

26. A heat recovery system to recovery heat from an internal combustion engine of a vehicle having a cooling system with a water pump for cooling fluid of the internal combustion engine, comprising:

an enclosure having apertures for airflow;

a heater core mounted in the enclosure having a pair of heater core fluid coupling ends;

a blower mounted in the enclosure and configured to blow air through the heater core and the apertures;

a pair of fluid lines having first and second ends, the first ends fluidly coupled to the heater core fluid coupling ends;

electrical conductors electrically connected to the blower;

one or more fluid pumps configured for mounting to the vehicle to travel therewith, the one or more fluid pumps being separate from the water pump, the one or more fluid pumps fluidly connected to the pair of fluid lines and to the heater core and configured to circulate the cooling fluid therethrough;

a coupling assembly configured for mounting to the vehicle to travel therewith, the coupling assembly including:

a second pair of fluid lines configured to be connected to the cooling system to receive the cooling fluid, the second pair of fluid lines having first cooling system ends configured to be connected to the cooling system to receive the cooling fluid and second cooling system ends opposite the first cooling system ends; and

one or more valves fluidly coupled between the second cooling system ends and the pair of fluid lines, the one or more valves being selectively operable to stop flow of the cooling fluid from or to the heater core through the pair of fluid lines;

a temperature sensor operably connected to the cooling fluid flowing through the heater core and configured to provide an output indicative of temperature of the cooling fluid;

a housing mountable to the vehicle to travel with the vehicle; and

a control device disposed in the housing and operably connected to the one or more valves and configured to receive an input indicative of a leak in the flow of the cooling fluid to the heater core and operate the one or more valves to stop the flow of the cooling fluid through the second pair of fluid lines based on the input, the control device being connected to the temperature sensor to receive the output indicative of temperature, the control device being configured to operate the one or more fluid pumps based on the output indicative of temperature, and the control device being further configured to operate the one or more fluid pumps when the water pump is not operating to circulate the cooling fluid and control the flow of the cooling fluid from the cooling system through the heater core.

27. The heat recovery system of claim 26 wherein the control device includes another output configured to control the engine so as to start and stop the engine generating heated cooling fluid based on the output from the temperature sensor.

28. The heat recovery system of claim 26 and further comprising a pressure sensor configured to provide an output indicative of pressure of the cooling fluid in the pair of fluid lines to the control device.

29. The heat recovery system of claim 26 wherein the one or more valves comprise a first valve fluidly coupled to a first fluid line of the pair of fluid lines and a second valve fluidly coupled to a second fluid line of the pair of fluid lines.

30. The heat recovery system of claim 26 and further comprising a first pair of fluid coupling ends and a second pair of fluid coupling ends couplable to the first pair of fluid coupling ends to form a quick disconnect fluid transfer coupling with the first pair of fluid coupling ends, the first pair of fluid coupling ends being fluidly connected to the heater core and the second pair of fluid coupling ends being connected to the first ends of the pair of fluid lines, and wherein the first pair of fluid coupling ends and the second pair of fluid coupling ends are configured to retain the cooling fluid in the heater core and the pair of fluid lines, respectively when the first pair of fluid coupling ends and the second pair of fluid coupling ends are disconnected from each other.

31. The heat recovery system of claim 30 and further comprising a cooling assembly operably coupled to the heater core to receive heat therefrom, the cooling assembly comprising a generator configured to receive the heat and heat cooling assembly fluid, an evaporator connected to the generator to receive heated cooling assembly fluid and cool the cooling assembly fluid to a liquid that is returned to the generator, and a cooling assembly blower configured to blow air on the evaporator.

32. The heat recovery system of claim 26 and further comprising a cooling assembly operably coupled to the heater core to receive heat therefrom, the cooling assembly comprising a generator configured to receive the heat and heat cooling assembly fluid, an evaporator connected to the generator to receive heated cooling assembly fluid and cool the cooling assembly fluid to a liquid that is returned to the generator, and a cooling assembly blower configured to blow air on the evaporator.

33. The heat recovery system of claim 26, wherein the control device is further configured to operate the one or more fluid pumps when the engine is not operating to circulate the flow of fluid through the heater core at a flow rate of 3-12 gallons per minute.

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